



General

Guideline Title

Management of pediatric cervical spine and spinal cord injuries. In: Guidelines for the management of acute cervical spine and spinal cord injuries.

Bibliographic Source(s)

Rozzelle CJ, Aarabi B, Dhall SS, Gelb DE, Hurlbert RJ, Ryken TC, Theodore N, Walters BC, Hadley MN. Management of pediatric cervical spine and spinal cord injuries. In: Guidelines for the management of acute cervical spine and spinal cord injuries. Neurosurgery. 2013 Mar;72(Suppl 2):205-26. [93 references] [PubMed](#)

Guideline Status

This is the current release of the guideline.

Recommendations

Major Recommendations

The rating schemes used for the strength of the evidence (Class I-III) and the levels of recommendations (Level I-III) are defined at the end of the "Major Recommendations" field.

Recommendations

Diagnostic

Level I

- Computed tomographic (CT) imaging to determine the condyle-C1 interval (CCI) for pediatric patients with potential atlanto-occipital dislocation (AOD) is recommended.

Level II

- Cervical spine imaging is not recommended in children who are >3 years of age and who have experienced trauma and who:
 - Are alert
 - Have no neurological deficit
 - Have no midline cervical tenderness
 - Have no painful distracting injury
 - Do not have unexplained hypotension
 - Are not intoxicated
- Cervical spine imaging is not recommended in children who are <3 years of age who have experienced trauma and who:

- Have a Glasgow Coma Scale (GCS) >13
- Have no neurological deficit
- Have no midline cervical tenderness
- Have no painful distracting injury
- Are not intoxicated
- Do not have unexplained hypotension
- Do not have motor vehicle collision (MVC), a fall from a height >10 feet, or non-accidental trauma (NAT) as a known or suspected mechanism of injury
- Cervical spine radiographs or high resolution CT is recommended for children who have experienced trauma and who do not meet either set of criteria above.
- Three-position CT with C1-C2 motion analysis to confirm and classify the diagnosis is recommended for children suspected of having atlanto-axial rotatory fixation (AARF).

Level III

- Anteroposterior (AP) and lateral cervical spine radiography or high-resolution CT is recommended to assess the cervical spine in children <9 years of age.
- AP, lateral, and open-mouth cervical spine radiography or high-resolution CT is recommended to assess the cervical spine in children >9 years of age.
- High-resolution CT scan with attention to the suspected level of neurological injury is recommended to exclude occult fractures or to evaluate regions not adequately visualized on plain radiographs.
- Flexion and extension cervical radiographs or fluoroscopy are recommended to exclude gross ligamentous instability when there remains a suspicion of cervical spinal instability following static radiographs or CT scan.
- Magnetic resonance imaging (MRI) of the cervical spine is recommended to exclude spinal cord or nerve root compression, evaluate ligamentous integrity, or provide information regarding neurological prognosis.

Treatment

Level III

- Thoracic elevation or an occipital recess is recommended in children <8 years of age to prevent flexion of the head and neck when restrained supine on an otherwise flat backboard for better neutral alignment and immobilization of the cervical spine.
- Closed reduction and halo immobilization are recommended for injuries of the C2 synchondrosis in children <7 years of age.
- Reduction with manipulation or halter traction is recommended for patients with acute AARF (<4 weeks duration) that does not reduce spontaneously. Reduction with halter or tong/halo traction is recommended for patients with chronic AARF (>4 weeks duration).
- Internal fixation and fusion are recommended in patients with recurrent and/or irreducible AARF.
- Consideration of primary operative therapy is recommended for isolated ligamentous injuries of the cervical spine and unstable or irreducible fractures or dislocations with associated deformity.
- Operative therapy is recommended for cervical spine injuries that fail non-operative management.

Summary

The available medical literature supports only 1 Level I recommendation for the management of pediatric patients with cervical spine or spinal cord injuries, specifically related to the diagnosis of patients with potential AOD. Level II and III diagnostic and Level III treatment recommendations are supported by the remaining medical evidence. The literature suggests that obtaining neutral cervical spine alignment in a child may be difficult when standard backboards are used. The determination that a child does not have a cervical spine injury can be made on clinical grounds alone is supported by Class II and Class III medical evidence. When the child is alert and communicative and is without neurological deficit, neck tenderness, painful distracting injury, or intoxication, cervical radiographs are not necessary to exclude cervical spinal injury. When cervical spine radiographs are utilized to verify or rule out a cervical spinal injury in children <9 years of age, only lateral and AP cervical spine views need be obtained. The traditional 3-view x-ray assessment may increase the sensitivity of plain spine radiographs in children >9 years of age. High resolution CT scan of the cervical spine provides more than adequate visualization of the cervical spine, but is not necessary in most children. CT and MRI are most appropriately used in selected cases to provide additional diagnostic information regarding a known or suspected injury (e.g., CT for AOD) or to further assess the spine/spinal cord in an obtunded child. The vast majority of pediatric cervical spine injuries can be effectively treated non-operatively. The most effective immobilization appears to be accomplished with either halo devices or Minerva jackets. Halo immobilization is associated with acceptable but considerable minor morbidity in children, typically pin site infection and pin loosening. The only specific pediatric cervical spine injury for which medical evidence supports a particular treatment paradigm is an odontoid injury in children <7 years of age. These children are effectively treated with closed reduction and immobilization. Primarily ligamentous injuries of the cervical spine in

children may heal with external immobilization alone, but are associated with a relatively high rate of persistent or progressive deformity when treated non-operatively. Pharmacological therapy and intensive care unit management schemes for children with spinal cord injuries have not been described in the literature.

Definitions:

Rating Scheme for the Strength of the Evidence: Modified North American Spine Society Schema to Conform to Neurosurgical Criteria as Previously Published and for Ease of Understanding and Implementation: Levels of Evidence for Primary Research Question^a

Class	Therapeutic Studies: Investigating the Results of Treatment	Diagnostic Studies: Investigating a Diagnostic Test	Clinical Assessment: Studies of Reliability and Validity of Observations, Including Clinical Examination, Imaging Results, and Classifications
I	High-quality randomized controlled trial with statistically significant difference or no statistically significant difference but narrow confidence intervals	Testing of previously developed diagnostic criteria on consecutive patients (with universally applied reference "gold" standard)	Evidence provided by 1 or more well-designed clinical studies in which interobserver and intraobserver reliability is represented by a \bar{A} , statistic ≥ 0.60 or an intraclass correlation coefficient of ≥ 0.70
	Systematic review ^b of Class I randomized controlled trials (and study results were homogeneous ^c)	Systematic review ^b of Class I studies	
II	Lesser-quality randomized controlled trial (e.g., <80% follow-up, no blinding, or improper randomization)	Development of diagnostic criteria on consecutive patients (with universally applied reference "gold" standard)	Evidence provided by 1 or more well-designed clinical studies in which interobserver and intraobserver reliability is represented by a \bar{A} , statistic of 0.40–0.60 or an intraclass correlation coefficient of 0.50–0.70
	Prospective ^d comparative study ^e	Systematic review ^b of Class II studies	
	Systematic review ^b of Class II studies or Class I studies with inconsistent results	Study of nonconsecutive patients; without consistently applied reference "gold" standard	
	Case-control study ^g	Systematic review ^b of Class III studies	
	Retrospective ^f comparative study ^e	Case-control study	
	Systematic review ^b of Class II studies		
III	Case series ^h	Poor reference standard	Evidence provided by 1 or more well-designed clinical studies in which interobserver and intraobserver reliability is represented by a \bar{A} , statistic of <0.40 or an intraclass correlation coefficient of <0.50
	Expert opinion	Expert opinion	

^aA complete assessment of quality of individual studies requires critical appraisal of all aspects of the study design.

^bA combination of results from 2 or more prior studies.

^cStudies provided consistent results.

^dStudy was started before the first patient enrolled.

^ePatients treated 1 way (e.g., halo vest orthosis) compared with a group of patients treated in another way (e.g., internal fixation) at the same institution.

^fThe study was started after the first patient was enrolled.

^gPatients identified for the study on the basis of their outcome, called "cases" (e.g., failed fusion), are compared with those who did not have outcome, called "controls" (e.g., successful fusion).

^hPatients treated 1 way with no comparison group of patients treated in another way.

Levels of Recommendation

Level I	Generally accepted principles for patient management, which reflect a high degree of clinical certainty (usually this requires Class I evidence which directly addresses the clinical questions or overwhelming Class II evidence when circumstances preclude randomized clinical trials)
Level II	Recommendations for patient management which reflect moderate clinical certainty (usually this requires Class II evidence or a strong consensus of Class III evidence)
Level III	Other strategies for patient management for which the clinical utility is uncertain (inconclusive or conflicting evidence or opinion)

Clinical Algorithm(s)

None provided

Scope

Disease/Condition(s)

Cervical spine and spinal cord injuries, including:

- Atlanto-occipital dislocation
- Atlantoaxial rotatory subluxation or fixation (acute or chronic; recurrent and/or irreducible)

Guideline Category

Diagnosis

Evaluation

Management

Treatment

Clinical Specialty

Neurological Surgery

Neurology

Orthopedic Surgery

Pediatrics

Radiology

Intended Users

Advanced Practice Nurses

Emergency Medical Technicians/Paramedics

Hospitals

Nurses

Physicians

Guideline Objective(s)

To address the unique aspects of children with real or potential cervical spinal injuries and provide recommendations regarding their management

Target Population

Pediatric patients with cervical spine and spinal cord injuries

Interventions and Practices Considered

Diagnosis/Evaluation

1. Computed tomographic (CT) imaging to determine the condyle-C1 interval (CCI)
2. Cervical spine radiography (anteroposterior [AP], lateral, open-mouthed, flexion and extension)
3. High-resolution CT
4. Three-position CT with C1-C2 motion
5. Fluoroscopy
6. Magnetic resonance imaging (MRI) of the cervical spine

Treatment/Management

1. Thoracic elevation or an occipital recess
2. Closed reduction and halo immobilization
3. Reduction with manipulation or halter traction
4. Reduction with halter or tong/halo traction
5. Internal fixation and fusion
6. Primary operative therapy

Major Outcomes Considered

- Sensitivity, specificity, and utility of diagnostic imaging studies
- Fusion (success) rate
- Complication rates of immobilization and surgery

Methodology

Methods Used to Collect/Select the Evidence

Hand-searches of Published Literature (Primary Sources)

Hand-searches of Published Literature (Secondary Sources)

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Search Criteria

Incorporating and expanding upon the first iteration of these guidelines, a National Library of Medicine (PubMed) computerized literature search from 1966 to 2011 was undertaken using Medical Subject Headings in combination with "spinal cord injuries" and "child" and yielded 1125 citations. These citations were reviewed in combination with "cervical vertebra," "spinal injuries," and "child" which yielded 197 citations. Non-English language citations were deleted. The remaining abstracts were reviewed for those that described children who had sustained or were being

evaluated for a cervical spinal cord or cervical spinal column injury. Articles describing the clinical aspects and management of children were used to generate these guidelines. Case reports were excluded. Of the 80 articles meeting selection criteria, 1 provided Class I medical evidence for diagnostic imaging in atlanto-occipital dislocation (AOD). In addition, there were 10 Class II medical evidence studies addressing diagnostic imaging in children. There was only 1 Class II medical evidence study concerning treatment. All remaining articles were case series representing Class III medical evidence.

Number of Source Documents

Eighty articles are provided in Evidentiary Table format (see Tables 1 and 2 in the original guideline document)

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Rating Scheme for the Strength of the Evidence: Modified North American Spine Society Schema to Conform to Neurosurgical Criteria as Previously Published and for Ease of Understanding and Implementation: Levels of Evidence for Primary Research Question^a

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^gPatients identified for the study on the basis of their outcome, called "cases" (e.g., failed fusion), are compared with those who did not have outcome, called "controls" (e.g., successful fusion).

^hPatients treated 1 way with no comparison group of patients treated in another way.

Methods Used to Analyze the Evidence

Review of Published Meta-Analyses

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

Selected articles were carefully reviewed by the authors. Evidentiary tables were created (refer to Tables 1 and 2 in the original guideline document) that reflected the strengths and weaknesses of each article.

On occasion, the assessed quality of the study design was so contentious and the conclusions so uncertain that the guideline authors assigned a lower medical evidence classification than might have been expected without such a detailed review. In every way, adherence to the Institute of Medicine's criteria for searching, assembling, evaluating, and weighing the available medical evidence and linking it to the strength of the recommendations presented in this document was carried out.

Articles that did not achieve immediate consensus among the author group were discussed extensively until a consensus was reached. Very few contributions required extensive discussion. Most articles were easily designated as containing Class I, II, or III medical evidence using the criteria set forth by the author group at the initiation of the literature evaluation process (see the "Rating Scheme for the Strength of the Evidence" field).

Methods Used to Formulate the Recommendations

Expert Consensus

Description of Methods Used to Formulate the Recommendations

The current author group was selected for its expertise in spinal surgery (both neurosurgical and orthopedic), neurotrauma, clinical epidemiology, and, in several cases, prior experience with guideline development. The topics chosen for inclusion in this iteration of these guidelines are contemporary and pertinent to the assessment, evaluation, care, and treatment of patients with acute cervical spine and/or spinal cord injuries.

Rating Scheme for the Strength of the Recommendations

Levels of Recommendation

Level I	Generally accepted principles for patient management, which reflect a high degree of clinical certainty (usually this requires Class I evidence which directly addresses the clinical questions or overwhelming Class II evidence when circumstances preclude randomized clinical trials)
Level II	Recommendations for patient management which reflect moderate clinical certainty (usually this requires Class II evidence or a strong consensus of Class III evidence)
Level III	Other strategies for patient management for which the clinical utility is uncertain (inconclusive or conflicting evidence or opinion)

Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

Method of Guideline Validation

Not stated

Description of Method of Guideline Validation

Not applicable

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The type of supporting evidence is identified and graded for each recommendation (see the "Major Recommendations" field).

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

Appropriate management of children with real or potential cervical spinal injuries that addresses the distinct, unique aspects of management of this patient group compared to adult patients

Potential Harms

Complications of Therapeutic Cervical Spine Immobilization (Halo and Minerva Devices)

- Pin-site infection including purulent infections
- Pin loosening
- Dural penetration
- Transient supraorbital nerve injury
- Skin breakdown from Minerva orthosis

Perioperative Complications

- Vertebral artery injuries
- Dysphagia due to malpositioned C1 lateral mass screw

Please refer to the original guideline document for more information regarding potential harms.

Qualifying Statements

Qualifying Statements

- Medical evidence-based guidelines are not meant to be restrictive or to limit a clinician's practice. They chronicle multiple successful

treatment options (for example) and stratify the more successful and the less successful strategies based on scientific merit. They are not absolute, "must be followed" rules. This process may identify the most valid and reliable imaging strategy for a given injury, for example, but because of regional or institutional resources, or patient co-morbidity, that particular imaging strategy may not be possible for a patient with that injury. Alternative acceptable imaging options may be more practical or applicable in this hypothetical circumstance.

- Guidelines documents are not tools to be used by external agencies to measure or control the care provided by clinicians. They are not medical-legal instruments or a "set of certainties" that must be followed in the assessment or treatment of the individual pathology in the individual patients we treat. While a powerful and comprehensive resource tool, guidelines and the recommendations contained therein do not necessarily represent "the answer" for the medical and surgical dilemmas faced with many patients.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Implementation Tools

Mobile Device Resources

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

IOM Domain

Effectiveness

Identifying Information and Availability

Bibliographic Source(s)

Rozzelle CJ, Aarabi B, Dhall SS, Gelb DE, Hurlbert RJ, Ryken TC, Theodore N, Walters BC, Hadley MN. Management of pediatric cervical spine and spinal cord injuries. In: Guidelines for the management of acute cervical spine and spinal cord injuries. Neurosurgery. 2013 Mar;72(Suppl 2):205-26. [93 references] [PubMed](#)

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

Guideline Developer(s)

American Association of Neurological Surgeons - Medical Specialty Society

Congress of Neurological Surgeons - Professional Association

Source(s) of Funding

Congress of Neurological Surgeons

Guideline Committee

Guidelines Author Group of the Joint Section of Disorders of the Spine and Peripheral Nerves of the American Association of Neurological Surgeons and the Congress of Neurological Surgeons

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Financial Disclosures/Conflicts of Interest

The authors have no personal financial or institutional interest in any of the drugs, materials, or devices described in this guideline.

Guideline Status

This is the current release of the guideline.

Guideline Availability

Electronic copies: Available in Portable Document Format (PDF) and EPUB for eBook devices from the [Neurosurgery Web site](#)

Availability of Companion Documents

The following are available:

- Foreword. Guidelines for the management of acute cervical spine and spinal cord injuries. Neurosurgery 2013;72(3):1. Electronic copies: Available in Portable Document Format (PDF) from the [Neurosurgery Web site](#) .
- Commentary. Guidelines for the management of acute cervical spine and spinal cord injuries. Neurosurgery 2013;72(3):2-3. Electronic copies: Available in PDF from the [Neurosurgery Web site](#) .

- Introduction to the guidelines for the management of acute cervical spine and spinal cord injuries. Neurosurgery 2013;72(3):5-16. Electronic copies: Available in PDF from the [Neurosurgery Web site](#) .
- Methodology of the guidelines for management of acute cervical spine and spinal cord injuries. Neurosurgery 2013;72(3):17-21. Electronic copies: Available in PDF from the [Neurosurgery Web site](#) .

Patient Resources

None available

NGC Status

This NGC summary was completed by ECRI Institute on July 9, 2013. The information was verified by the guideline developer on October 3, 2013.

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